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研究計畫

設計與實作一基於混合雲架構於機上盒的銀髮族家庭健康照護系統

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摘要

　　在科技發展迅速的現代，遠距醫療在近年來已是一個被廣為討論的研究主題，無論是使用手機、電腦或電視來當資料傳輸媒界，都有許多相關的研究。我們可以在家紀錄多項生理資訊並且回報，而不需舟車勞頓前往醫院，但是對於不熟悉高科技的老人而言，這類高科技產品的推陳出新雖然造就了年輕一輩的方便，對於年邁的他們卻造成了一種負擔。但若一個居家照護系統只僅限於老人使用，便失去了其居家照護的核心價值，居家照護系統應是一個全家人均可使用的系統。

　　過去的居家醫療系統雖然便利，卻隱含著資料格式的問題，大多數的醫療系統都是和單一醫院配合使用，在轉診時便會造成醫療資訊彼此間難以交換的問題，並且大量的資料會造成系統負擔過大，長久以來會降低系統效率。並且此類居家醫療系統較缺乏個人化之管理，以帳號密碼登入的形式造成了年老長輩的不便，此系統希望能以最簡單的方式，讓螢幕前的銀髮族能輕鬆開始自己與系統的私人互動。

　　在本研究中，我們利用 Android 平台實現一個能夠提供使用者一個較為友善及便利操作介面的機上盒，透過藍芽介面之血壓計、體重計來獲取使用者的生理資訊，除了將資訊顯示在電視畫面上，同時也將此筆最新資料上傳至雲端，供醫療院所登入取用。本研究所提出之系統除了可以做到家庭中的個人健康管理，同時可以提供遠距醫療及院際間資訊交換的功能，並採用了混合式雲端的儲存架構，將最新的資料存在公有雲(public cloud)中，供醫護人員及使用者能夠透過瀏覽器快速得到所需的健康資訊，而較舊的資料則放在私有雲(private cloud)，即將取用頻率較低的資料存放在家中的 SD 卡中，這樣的設計能夠有效降低雲端資料庫所需處理的資料量，提升系統效率。本研究提出了一個實現於居家照護系統，能夠解決過去集中式雲端資料量過載及壅塞問題的雲端架構，能夠有效增進系統效率。

關鍵詞：數位電視、家庭健康照護、混合雲、機上盒、遠距醫療

1. Research background and goals

As science and technology are getting advanced, researches on homecare service have become increasingly common. These telemedicine services are designed to provide a more convenient bridge that enables users to directly interact with medical staffs. Although such designs may seem effective and helpful, senior citizens might be unfamiliar with and burdened by contemporary technology such as homecare products that constantly change.

Although previous homecare systems have been convenient, storing abundant information has become an increasingly critical concern of medical service providers. Large quantities of data cause overloading and reduce system efficiency. Database efficiency has been considered in systems used for various services such as online storage or online shopping; however, research on homecare systems has seldom focused on the efficiency of the entire system. In this study, a system was designed for elder's use that can store medical data by using a combination of local and remote storage, effectively reducing system overload. A set-top box was used as the platform to resolve the aforementioned challenges to senior citizens, and hybrid architecture was used for storing data.

2. Related Works

Numerous studies have explored homecare systems that feature televisions (TVs) and set-top boxes. Compared with PC-based (Wang et al., 2014) or mobile-based (Yu et al., 2013) systems, TV-based home care systems provide users with a more friendly and convenient platform. Using a TV-based home care system yields numerous advantages such as a user-friendly graphical user interface (GUI) that simplifies the use of the system. However, previous studies have seldom discussed data storage designs and the problems associated with large amounts of data that expand over time. By 2017, data traffic is estimated to be 7.7 ZB (Cisco System, 2012-2017); therefore, solving the overload problem caused by big data traffic has become a critical concern. In this study, a set-top-box-based homecare system featuring novel cloud architecture (i.e., hybrid architecture) was proposed to resolve the problems caused by considerable quantities of medical information. Therefore, the first item that must be considered is the storage center design. A literature review was conducted to compare the designs used in previous storage centers. Regarding data storage location, previous studies can be classified into three categories: (1) set-top boxes; (2) cloud; and (3) hybrid set-top-box and cloud systems. The advantages and disadvantages of each system are discussed as follows.

Regarding (Joon-Ho et al., 2010; Kuusik et al., 2010), the received data were stored in a set-top box. The medical data were stored in a local machine and sent to a public cloud when requested; in other words, data were not automatically transmitted to the public cloud. This architecture is advantageous in that personal privacy is relatively protected, data are readable and accessible regardless of Internet connectivity, and users can efficiently manage their personal information. However, this architecture likely facilitates a closed telemedicine service because limited interaction with medical staff members would make it difficult for physicians to assess the conditions of patients. Furthermore, this type of telemedicine service may be ineffective for conducting referrals and information exchanges among

hospitals because medical staff members do not record the latest conditions of patients. In certain studies, data could not be extracted from set-top boxes; this can cause substantial problems when physicians or patients require their historical records. Therefore, this type of system is more suitable for personal measurement than for use in telemedicine. Because of Internet advancement, research into such systems is limited.

By leveraging Internet technology, numerous studies (Gambi & Gambi, 2008; Angius et al., 2008; Angius et al., 2008; Faro et al., 2010; Angius et al., 2011; Sorwar & Hasan, 2012; Hinderer et al., 2012; Vázquez et al., 2012; Anido Rifon et al., 2013) have researched systems that instantly transmit data to a cloud instead of storing it in a local machine. Cloud storage offers several advantages in that the set-top box does not require local storage; thus, the goals of telemedicine can be achieved. Information can be immediately updated and exchanged between medical staff members and patients. Physicians can readily determine the conditions of patients and make accurate diagnoses. In addition, physicians can remotely interview patients and assist them in emergencies. Exchanging information among hospitals is feasible by using the Internet. However, despite this apparent convenience, substantial data would be lost during transmission if the network becomes disconnected, potentially causing misdiagnoses. Because such cloud systems lack local storage, misdiagnosis may become a considerable problem. Moreover, if a cloud-based system has too many users, this type of data management could cause network congestion and database overload. Furthermore, hacking creates potential user-privacy concerns. Compared with storing data in a local set-top box, storing data on a remote cloud server is relatively closer to achieving the fundamental goals of telemedicine.

In (Pan et al., 2012), data were stored using both a local set-top box and cloud server. The primary feature of this system is the local storage and set-top box that duplicates and transfers information to a remote server. The advantage is that patient information is efficiently preserved. If the network is disconnected, no problems occur because the local storage preserves the user information. However, this architecture reduplicates data on the home and hospital sides, causing wasted space as data are collected over time; thus, its disadvantages are similar to those of cloud-based systems. If excessive data are stored on the cloud server, particularly multimedia data, such as videos of daily monitoring or photographs of the disease conditions of patients, cloud overloading would occur (Hanawa et al., 2013; Ni et al., 2013). In the current sub-project, a hybrid cloud architecture system was proposed, consisting of a set-top box and cloud system designed to prevent system overload. Several hybrid architectures are proposed to overcome the disadvantages of those used in previous studies. After exploring several hybrid architectures, the most suitable architecture was selected for designing the hybrid cloud-based homecare system.

參考文獻

1. Wang, X., Gui, Q., Liu, B., Jin, Z., & Chen, Y. (2014). Enabling smart personalized healthcare: a hybrid mobile-cloud approach for ecg telemonitoring. doi:10.1109/JBHI.2013.2286157
2. Yu, W.D., Kollipara, M., Penmetsa, R., & Elliadka, S. (2013). A distributed storage solution for cloud based e-Healthcare Information System. *2013 IEEE 15th International Conference on*

E-Health Networking, Applications & Services (Healthcom), Lisbon, Portuguese, 476-480. doi:10.1109/HealthCom.2013.6720723

3. Cisco System, Inc. *Cisco Global Cloud Index: Forecast and Methodology*, 2012–2017. Available online: http://www.cisco.com/c/en/us/solutions/collateral/service-provider/global-cloud-index-gci/Cloud_Index_White_Paper.html (accessed on 25 March 2014).

4. Joon-Ho, L., Chanyong, P., & Soo-Jun, P. (2010). Home healthcare settop-box for Senior Chronic Care using ISO/IEEE 11073 PHD standard. *Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC),* 216-219. doi:10.1109/IEMBS.2010.5627845.

5. Kuusik, A., Reilent, E., Lõõbas, I., & Parve, M. (2010). Semantic formal reasoning solution for personalized home telecare. In *Mechanical and Electrical Technology (ICMET), 2010 2nd International Conference on,* 72-76. doi:10.1109/ICMET.2010.5598496

6. Gambi, E. A., & Gambi, A. G. E. (2008). A Digital Television Based Solution for Remote Health Care of Rural People. In *Consumer Electronics, 2008. ICCE 2008. Digest of Technical Papers. International Conference on,* 1-2. doi:10.1109/ICCE.2008.4587910

7. Angius, G., Pani, D., Raffo, L., Seruis, S., & Randaccio, P. (2008). A pervasive telemedicine system exploiting the DVB-T technology. In *Pervasive Computing Technologies for Healthcare, 2008. PervasiveHealth 2008. Second International Conference on,* 228-231. doi:10.1109/PCTHEALTH.2008.4571076

8. Angius, G., Pani, D., Raffo, L., & Randaccio, P. (2008). A DVB-T framework for the remote monitoring of cardiopathic and diabetic patients. In *Computers in Cardiology, 2008,* 1001-1004. doi:10.1109/CIC.2008.4749213

9. Faro, A., Giordano, D., Kavasidis, I., & Spampinato, C. (2010). A web 2.0 telemedicine system integrating TV-centric services and Personal Health Records. In *Information Technology and Applications in Biomedicine (ITAB), 2010 10th IEEE International Conference on,* 1-4. doi:10.1109/ITAB.2010.56878010

10. Angius, G., Pani, D., Raffo, L., & Randaccio, P. (2011). KeepInTouch: a telehealth system to improve the follow-up of chronic patients. In *Collaboration Technologies and Systems (CTS), 2011 International Conference on,* 311-318. doi:10.1109/CTS.2011.5928703.

11. Sorwar, G., & Hasan, R. (2012). Smart-tv based integrated e-health monitoring system with agent technology. In *Advanced Information Networking and Applications Workshops (WAINA), 2012 26th International Conference on*, 406-411. doi:10.1109/WAINA.2012.155

12. Hinderer, K. U., Friedrich, P., & Wolf, B. (2012). Home care: A telematic rehabilitation exerciser. In *Consumer Electronics-Berlin (ICCE-Berlin), 2012 IEEE International Conference on,* 15-18. doi:10.1109/ICCE-Berlin.2012.6336525

13. Vázquez, C. G., Martínez, E. M., Duboy, M. A. V., & Oliva, A. G. (2012). Distributed System for Cognitive Stimulation Over Interactive TV. *Information Technology in Biomedicine, IEEE Transactions on*, *16*(6), 1115-1121. doi:10.1109/TITB.2012.2220782

14. Anido Rifon, L. E., Rivas Costa, C., Gomez Carballa, M., Valladares Rodriguez, S., & Femandez Iglesias, M. J. (2013). Improving the quality of life of dependent and disabled people through home

automation and tele-assistance. In *Computer Science & Education (ICCSE), 2013 8th International Conference on,* 478-483. doi:10.1109/ICCSE.2013.6553958

15. Pan, Q., Yang, P., Zhang, R., Lin, C., Gong, S., Li, L., & Ning, G. (2012). A mobile health system design for home and community use. In*Biomedical and Health Informatics (BHI), 2012 IEEE-EMBS International Conference on,* 116-119. doi:10.1109/BHI.2012.6211521.

16. Hanawa, T., Paomin, C., Toda, T., Fujita, K., & Ideguchi, N. (2013). A simple web-based image database system for facilitating medical care in dermatological clinics. In *Medical Information and Communication Technology (ISMICT), 2013 7th International Symposium on,* 247-251. doi:10.1109/APCloudCC.2012.6486502.

17. Ni, B., Wang, G., & Moulin, P. (2013). Rgbd-hudaact: A color-depth video database for human daily activity recognition. In *Consumer Depth Cameras for Computer Vision,* 193-208. doi:10.1109/ICCVW.2011.6130379.

18. World Health Organization (WHO). World Health Organization (WHO) | Online Q&A, 2013. Available online: http://www.who.int/features/qa/en/ (accessed on 20 February 2014)

A set-top box and hybrid cloud based homecare system for elders

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Abstract

As science and technology are getting advanced, Telemedicine has become a prevalent topic in recent years and several telemedicine systems have been proposed; however, to the users, these systems exhibit disadvantages to not fit the daily requirements. Several homecare systems have been proposed on several platforms, such as a system hosted on personal computers (PCs) or smartphones. These telemedicine services are designed to provide a more convenient bridge that enables users to directly interact with medical staffs. Although such designs may seem friendly and helpful, senior citizens might be unfamiliar with and burdened by contemporary technology such as homecare products that constantly change. In addition, if a telemedicine system is designed for only individual use, the core goal of homecare may not be attained. Furthermore, the large amount of information produced from increasing medical data from patients will be a big problem which will reduce the system efficiency and cause congestion when many users access the information at the same time.

In this study, a set-top box integrated with the Android platform to provide a convenient and user-friendly interface was proposed. The set-top box was designed to receive vital data measured from medical devices through a Bluetooth interface. The received information is both displayed on a digital television (DTV) and immediately uploaded to a cloud. Furthermore, this platform can be used to manage the health situations of family members. The platform can also be used to provide telemedicine services and exchange information among hospitals. Thus, a novel, hybrid cloud architecture is proposed in this study. Updated information is stored in a public cloud, enabling medical staffs to rapidly access information so that they can facilitate diagnosing patients. Outdated information is stored in a private cloud, enabling users to efficiently access historical records by using a backend management system. The total data quantity is reduced in the long term, and the efficiency of the database is improved. The proposed design offers a robust architecture for storing data in an elder homecare system, resolving the overloading and congestion problems inherent to a centralized architecture because the data quantity increases and improves system efficiency.

Keywords: digital television, homecare, hybrid cloud, set-top box, telemedicine